

REMARKS

The Office Action mailed May 17, 2002 has been reviewed and carefully considered. Claims 5 and 8 have been amended. Claims 5 and 8 are pending in this application, with claim 5 being the only independent claim. Reconsideration of the above-identified application, as herein amended and in view of the following remarks, is respectfully requested.

In the Office Action mailed May 17, 2002, claims 5 and 8 stand rejected under 35 U.S.C. §103 as unpatentable over Simsek, "Dynamic Simulation of Dual-Line Continuous Strip Processing Operations" in view of U.S. Patent No. 5,509,460 (Chun).

Before discussing the cited prior art and the Examiner's rejections of the claims in view of that art, a brief summary of the present invention is appropriate. The present invention relates to a method and system for determining and controlling the material flow of continuous cast slabs on the transport and processing paths between the casting installation and the rolling mills by monitoring and optimizing the temperature on the transport and processing paths between the continuous casting-installation and the rolling mill. According to the invention, the amount of heat and the temperature profile of the slab is determined using the known temperature of the liquid phase at the mold exit of the continuous-casting installation and given knowledge of the physical parameters of the slab. The convective mixing of the amount of heat contained in the slab and the time-dependent heat loss from the inhomogeneously cooling slab to the surrounding medium are calculated using a mathematical physical model. The surface temperature of the slab is also measured over time. The results of the calculation and the measured temperatures are used to control the material flow of the slabs in the transport and processing paths between the casting installation and the rolling mills.

Accordingly, the present invention does not merely take one temperature measurement to control one part of the process. Rather, the present invention teaches that calculations and measurements of surface temperatures are performed over time to control the material flow of the slabs in the transport and processing paths between the casting installation and the rolling mills.

Independent claim 5 has been amended and includes the recitation "during the material flow of continuous-cast slabs in the transport and processing paths, measuring a surface temperature of the continuous-cast slab over time and determining an amount of heat and a temperature profile of the continuous-cast slab over time by calculating the convective mixing of the amount of heat contained in the continuous-cast slab and the time-dependent heat loss from the inhomogenously cooling of the continuous-cast slab". Support for the recitation of measuring the surface temperature over time "during the material flow of continuous-cast slabs in the transport and processing paths" is found in the original specification at page 3, lines 14-16, page 5, lines 20-23, and page 6, lines 3-6.

Simsek discloses a simulation of dual-line continuous strip processing operations in which finite element numerical techniques are used to calculate the minimum heating time requirements for a range of casting speeds. As stated in the Office Action, Simsek fails to disclose the steps of determining the temperature of the fluid phase after casting and physical parameters of the slab and fails to disclose controlling the material flow of the slab from the casting installation to the roll mills using a slab monitoring system.

Chun discloses a solid/liquid interface detection in continuous casting processes by gamma-ray attenuation. According to Chun, gamma rays are passed through a partially solidified strand and a detector is used to determine the liquid metal/ solid metal interface by relying on the

different gamma radiation attenuation characteristics of the solid metal and liquid metal. The casting machine may be controlled based on the detector output (see col. 3, lines 5-12). However, it

is respectfully submitted that Chun fails to teach or suggest that the strand is controlled on the transport and processing paths between the casting installation and the rolling mill using measurements of the surface temperature over time. Chun teaches only that the casting machine is controlled for controlling the strand at the exit of the casting installation. As stated by the Examiner, a material flow usually follows the casting installation. However, Chun fails to teach that a material flow following the exit of the casting installation is controlled. Typically, strands are not sent directly to the rolling mill but are first fed through various heating furnaces, shuttle furnaces, holding furnaces (as disclosed by Simsek) and other transport and processing stages before being sent through the rolling mills. The original application at page 3, lines 20-21 discloses further material flows between the continuous casting installation and the rolling mill such as warm charge rolling, hot charge rolling, cold charge rolling, or hot direct rolling. The present invention controls material flow through these various stages using calculated values of heat content and temperature profiles and using measured surface temperatures, as recited in independent claim 5.

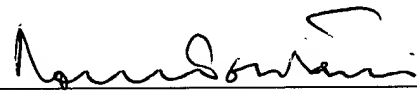
Even if the strand of Chun were fed directly to a rolling mill, Chun fails to teach the claimed invention. In contrast, Chun makes only one measurement at the casting installation exit to determine the liquid/solid metal interface. Accordingly, Chun controls only the liquid/solid interface at the casting installation exit and fails to teach or suggest "measuring a surface temperature of the continuous-cast slab over time and determining an amount of heat and a temperature profile of the continuous-cast slab over time by calculating the convective mixing of the amount of heat contained in the continuous-cast slab and the time-dependent heat loss from the inhomogenously cooling of the continuous-cast slab" and "controlling the material flow of the

continuous-cast slab in the transport and processing paths between the continuous-casting installation and rolling mills via a slab-monitoring system of the continuous-casting installation using the measured surface temperature of the continuous-cast slab and the amount of heat and the temperature profile determined in said step b. as an input to the slab-monitoring system", as recited in independent claim 5.

Accordingly, it is respectfully submitted that independent claim 5 is allowable over Simsek in view of Chun. Dependent claim 8 has been amended to be consistent with the amendments to independent claim 5 and is allowable for at least the same reasons as independent claim 5.

The application is now deemed to be in condition for allowance and notice to that effect is solicited.

Respectfully submitted,
COHEN, PONTANI, LIEBERMAN & PAVANE

By 
Thomas C. Pontani
Reg. No. 29,763
551 Fifth Avenue, Suite 1210
New York, New York 10176
(212) 687-2770

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AMENDMENTS TO THE SPECIFICATION AND CLAIMS SHOWING CHANGES

In the Claims:

Amend claims 5 and 8 as follows:

5. (Amended) A method for determining and controlling the material flow of continuous-cast slabs in transport and processing paths between the continuous-casting installation and a rolling mill by monitoring and optimizing the temperature on the transport [path] and processing paths [of the continuous-cast slabs between the continuous-casting installation and a rolling mill], said method comprising the steps of :

a. determining a temperature of the liquid phase of the continuous-cast slab at a mold exit of the continuous-casting installation and physical parameters of the continuous-cast slab including temperature-dependent material values comprising at least one of density ρ , specific heat C_p , thermal conductivity λ , and scale properties [and determining a surface temperature of the continuous-cast slab];

b. during the material flow of continuous-cast slabs in the transport and processing paths, measuring a surface temperature of the continuous-cast slab over time and determining an amount of heat and a temperature profile of the continuous-cast slab over time by calculating the convective mixing of the amount of heat contained in the continuous-cast slab and the time-dependent heat loss from the inhomogenously cooling of the continuous-cast slab, wherein the step of calculating comprises using a mathematical-physical model calculated using one of a two-dimensional finite element method, a finite difference method, and software using formulas derived from off-line studies; and

c. controlling the material flow of the continuous-cast slab in the transport and processing paths between the continuous-casting installation and rolling mills via a slab-monitoring

system of the continuous-casting installation [and] using the measured surface temperature of the continuous-cast slab [determined in said step a.] and the amount of heat and the temperature profile determined in said step b. as an input to the slab-monitoring system.

8. (Amended) The method of claim 5, wherein said step c. further comprises automatically controlling the material flow via the slab monitoring system based on the amount of heat and the temperature profile determined in said step b. and the measured surface temperature of the continuous-cast slab.